

N O R T H C A R O L I N A

THE BURDEN OF

**Motor Vehicle Traffic-related Injuries
In
North Carolina**

**North Carolina
Injury and Violence Prevention
Branch**

NORTH CAROLINA DIVISION OF PUBLIC HEALTH

**North Carolina Department of Health and Human Services
February 2011**

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Katherine J. Harmon, MPH



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Acknowledgements:

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Highlights:

- The leading cause of injury death in North Carolina is motor vehicle collisions.
- In 2009, 1,342 North Carolinians lost their lives after sustaining an injury from a motor vehicle traffic (MVT)-related crash.
- The rate of MVT-related deaths is 14.1 deaths per 100,000 North Carolina residents.
- Since 1999, the rate of MVT-related deaths has dropped nearly 30 percent.
- Males are more than twice as likely to die from MVT-related injuries as females.
- Young adults between the ages of 16 and 20 have the highest rates of MVT-related deaths.

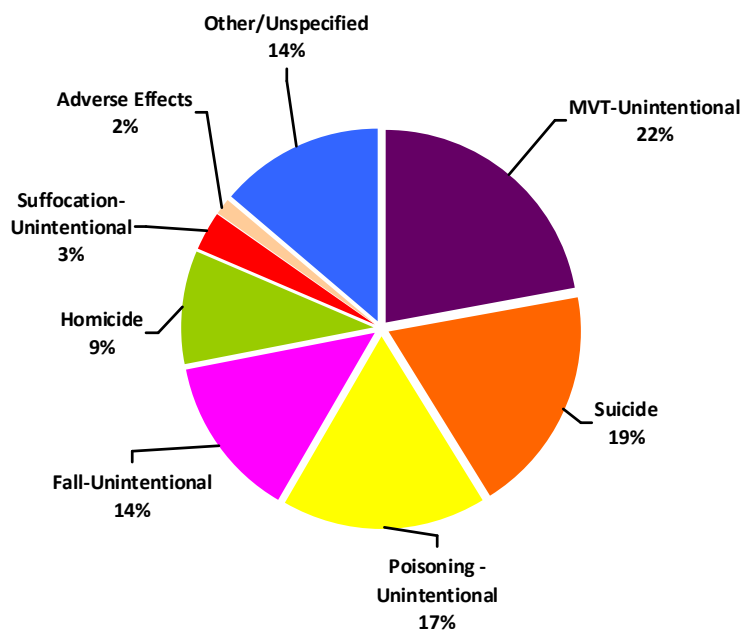
Section 1: Overview and Trends of Motor Vehicle Traffic (MVT) Injuries in North Carolina

Injury is the third-leading cause of death in North Carolina; only cancer and heart disease result in more deaths in the state. Injury is the leading cause of death in individuals between the ages of 1 and 60. In 2009, injury was the primary cause of death for 6,074 individuals.¹

The leading cause of injury death in N.C. and the leading cause of death of residents between the ages of one and 44 are motor vehicle traffic (MVT)-related crashes. MVT-related deaths account for over one-fifth of all injury deaths (Figure 1). Although the rate of MVT deaths has declined over the last decade, in 2009, there were 1,342 deaths, many of which were preventable.

The Centers for Disease Control and Prevention (CDC) defines an MVT-related event as “Any vehicle incident occurring on a public highway, street, or road.” An MVT-related injury can involve occupants of motorized vehicles, pedestrians, pedal cyclists, or occupants of non-motorized vehicles.² For the purposes of this document, MVT will refer *only* to unintentional injuries (this document will exclude motor vehicle crashes with homicidal, suicidal, or undetermined intent and crashes that occur on private property or off roads).

Figure 1. Percent of Injury Deaths by Type: N.C. Residents, 2009



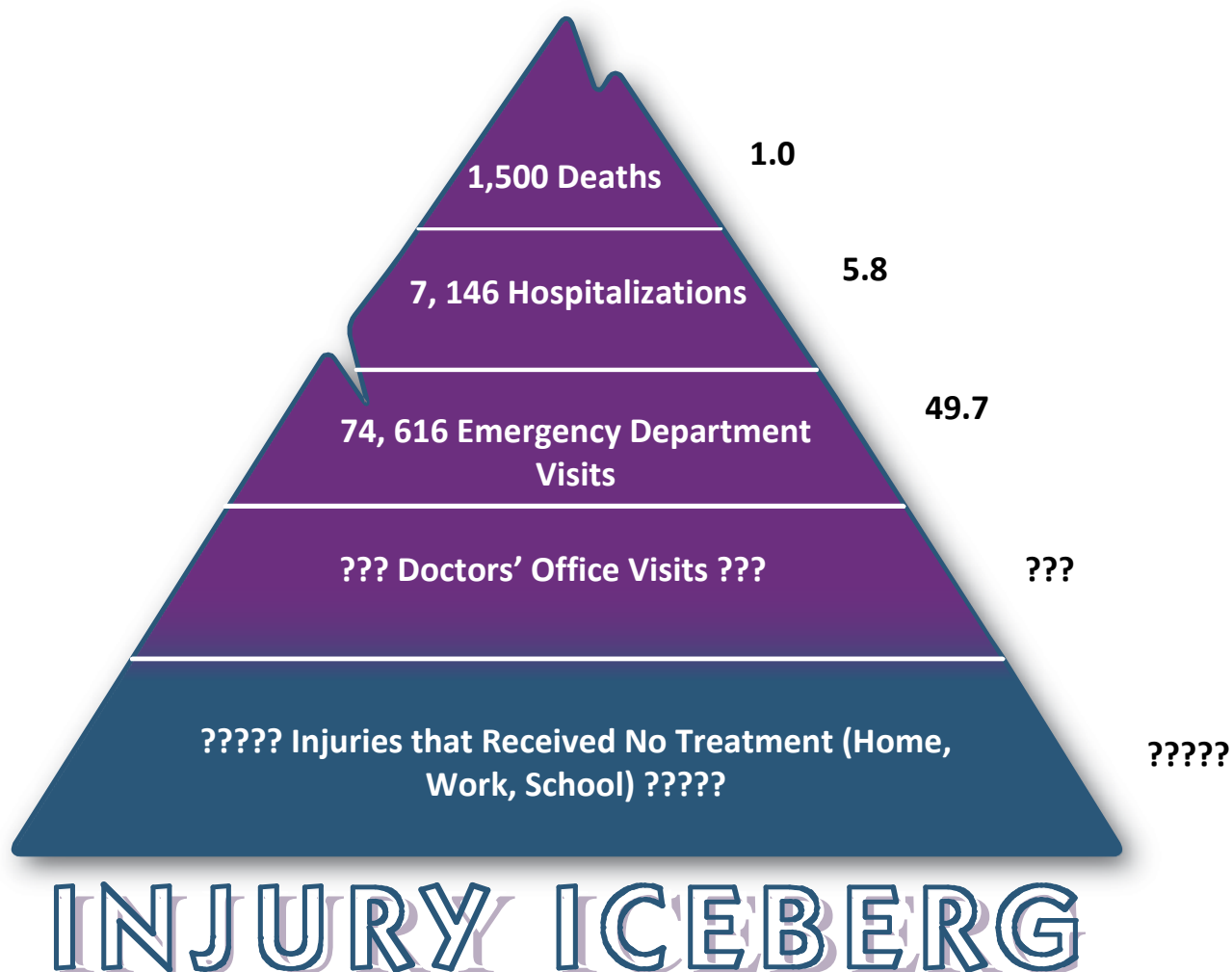
Data: N.C. Center for Health Statistics, 2009
Analysis: Injury Epidemiology & Surveillance Unit

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MVT crashes are expensive both in terms of lives lost, injuries sustained, and economic cost. In the United States, approximately 45,000 people died, 268,000 people were hospitalized, and 3.4 million people visited an emergency department (ED) due to a MVT-related crash in 2005. The estimated total medical and lost productivity costs of these fatal and nonfatal injuries was \$99 billion or \$500 for each licensed driver in the nation.³ These numbers do not reflect injured individuals who visited a primary care physician or those who did not seek medical attention.

The Injury Iceberg illustrates the overall burden that MVT-related injuries have on the state of North Carolina. 2008 data are used because it is the latest year available from all data sources. Deaths account for only the “tip of the iceberg” in regard to MVT-related injuries. For each death, there were 5.8 hospitalizations and 49.7 ED visits.^{4,5} Surveillance data are not available from outpatient clinics or for injuries that are medically unattended; however, those numbers are likely to be far higher than the number of ED visits (Figure 2).

Figure 2. The Injury Iceberg—MVT Injuries: N.C. Residents, 2008



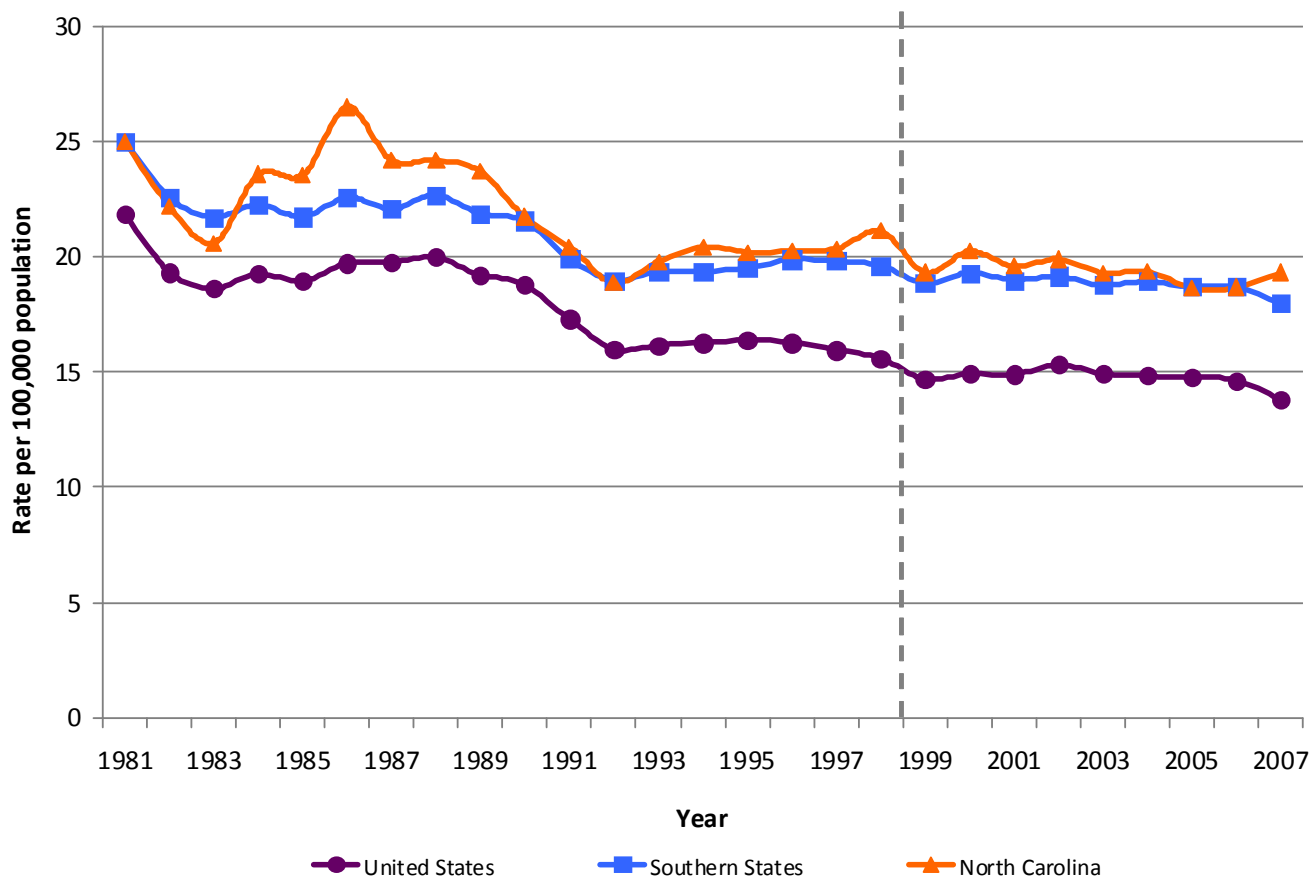
Data: Death, Hospital Discharge: N.C. Center for Health Statistics, 2008;
Emergency Department: NC DETECT, 2008
Analysis: Injury Epidemiology & Surveillance Unit

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In 2007, the last year that both national and state data are available from the Centers for Disease Control and Prevention (CDC), North Carolina had statistically significantly higher rates of death than the United States. Overall, between 1981 and 2007, rates for both North Carolina and the United States decreased from a peak in the late 1980s (Figure 3). In 2007, North Carolina had the 11th highest rate of MVT-related deaths in the nation after Mississippi, Montana, Alabama, South Carolina, Wyoming, Louisiana, Arkansas, West Virginia, Tennessee, and Oklahoma.⁶

Between 1992 and 2007, the rate of MVT-related deaths was relatively stable, fluctuating between 18.6 and 20.4 deaths per 100,000 North Carolina residents. Beginning in 2008, the rate of MVT-related deaths dropped substantially.⁷ Although data are not available from the CDC for the years 2008-2009, data from the National Highway Traffic Safety Administration (NHTSA) indicate a similar trend nationally. The reduction in deaths is believed to be due to many factors including rising gas prices, the economic downturn, unemployment, improvements in vehicle design, and highway safety programs.⁸

Figure 3. Comparison of Age-Adjusted Rates of MVT Deaths between the United States, Southern States,* and N.C.: 1981-2008



----- Change in ICD Mortality Coding

*Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

Data & Analysis: CDC WISQARS, 1981-2007

Section 2: Demographics of MVT-related Deaths

In 2009, 1,342 North Carolina residents died from MVT-related injuries. The age-adjusted rate for North Carolina was 14.1 deaths per 100,000 residents. Table 1 provides demographic estimates of the North Carolina population and Table 2 provides counts and rates of MVT-related deaths for select populations. In North Carolina certain populations are at a greater risk of dying from a fatal MVT crash than other populations:

- Men are more than twice as likely to die from MVT-related injuries as women. The rate of MVT-related deaths in men is 20.3 and 8.4 in women among North Carolina residents.
- Rates do not vary considerably between individuals of Hispanic and non-Hispanic ethnicity among North Carolina residents.
- In North Carolina, American Indians have the highest rate of death from MVT-related injuries of the racial groups examined, with a rate of 26.2 deaths, nearly double the rate of whites.
- Young adults between the ages of 16 and 25 make up over one-fourth of all deaths due to injuries sustained in an MVT crash in North Carolina. The rate is highest for young adults between 16 and 20 years old. A second peak in the rate of MVT-related crashes occurs in adults over the age of 75.

Definitions

The CDC defines a motor vehicle traffic-related incident as:

“Any vehicle incident occurring on a public highway, street, or road.”⁹

- MVT-related crashes must involve a motor vehicle (car, truck, van, SUV, etc.) and another motor vehicle, off-road vehicle, motorcycle, pedal cyclist, pedestrian, other transport vehicle, or object.
- If a report does not specify if a crash was traffic-related and the incident involved a motor vehicle crash, then it is assumed that the incident was traffic-related.
- If a report does not specify if a crash was traffic-related and the incident involved an off-road vehicle crash (crashes involving a motorcycle, ATV, go-cart, etc.), then it is assumed that the incident was not traffic-related.
- If fatal injuries were sustained when boarding/alighting a vehicle, then it is assumed that the incident was not traffic-related unless the report specifically noted that the injuries were traffic-related.

All MVT-related deaths and injuries are classified using the World Health Organization’s International Classification of Disease codes ICD-10 (deaths) and ICD-9-CM (nonfatal injuries). Supplemental information is provided in the Notes (page 28) and Glossary sections (page 29).^{10, 11}

Table 1: Selected Demographics of N.C. Residents, 2009		
	Number	Percent
Sex		
Male	4,590,185	48.9%
Female	4,790,699	51.1%
Hispanic Ethnicity[§]		
Hispanic	717,662	7.7%
Non-Hispanic	8,663,222	92.3%
Race[¶]		
Asian	211,842	2.3%
American Indian	122,425	1.3%
Black	2,068,139	22.0%
White	6,978,478	74.4%
Age Group[‡]		
0-15	2,028,276	21.6%
16-20	662,487	7.1%
21-25	656,551	7.0%
26-35	1,230,202	13.1%
36-45	1,335,371	14.2%
46-55	1,317,747	14.0%
56-65	1,042,094	11.1%
66-75	617,228	6.6%
>75	490,928	5.2%
Total	9,380,884	100.0%

Data: National Center for Health Statistics, 2009
 Analysis: Injury Epidemiology & Surveillance Unit

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Table 2: Selected Demographics of MVT-related Deaths: N.C. Residents, 2009

	Number	Percent	Rate [†]	95% Confidence Interval	
				<u>Lower</u>	<u>Upper</u>
Sex					
Male	929	69.2%	20.3	19.0	21.6
Female	413	30.8%	8.4	7.5	9.2
Hispanic Ethnicity[§]					
Hispanic	94	7.0%	13.5	10.9	16.2
Non-Hispanic	1,246	93.0%	14.0	13.2	14.8
Race[‡]					
Asian	8	0.6%	*	*	*
American Indian	33	2.5%	26.2	17.0	35.4
Black	289	21.6%	14.0	12.4	15.6
Other	5	0.4%	*	*	*
White	1,005	75.0%	14.1	13.3	15.0
Age Group[¶]					
0-15	60	4.5%	3.0	2.3	3.7
16-20	172	12.8%	26.0	22.1	29.9
21-25	170	12.7%	25.9	22.0	29.8
26-35	204	15.2%	16.6	14.3	18.9
36-45	170	12.7%	12.7	10.8	14.6
46-55	214	16.0%	16.2	14.0	18.4
56-65	144	10.7%	13.8	11.5	16.1
66-75	81	6.0%	13.1	10.2	16.0
>75	126	9.4%	25.7	21.2	30.2
Total	1,342	100.0%	14.1	13.4	14.9

*Rate is based on fewer than 20 deaths and is therefore considered statistically unreliable.

†All rates are age adjusted and per 100,000 North Carolina residents.

§Missing 2 of unknown ethnicity.

‡Missing 2 of unknown race.

¶Missing 1 of unknown age.

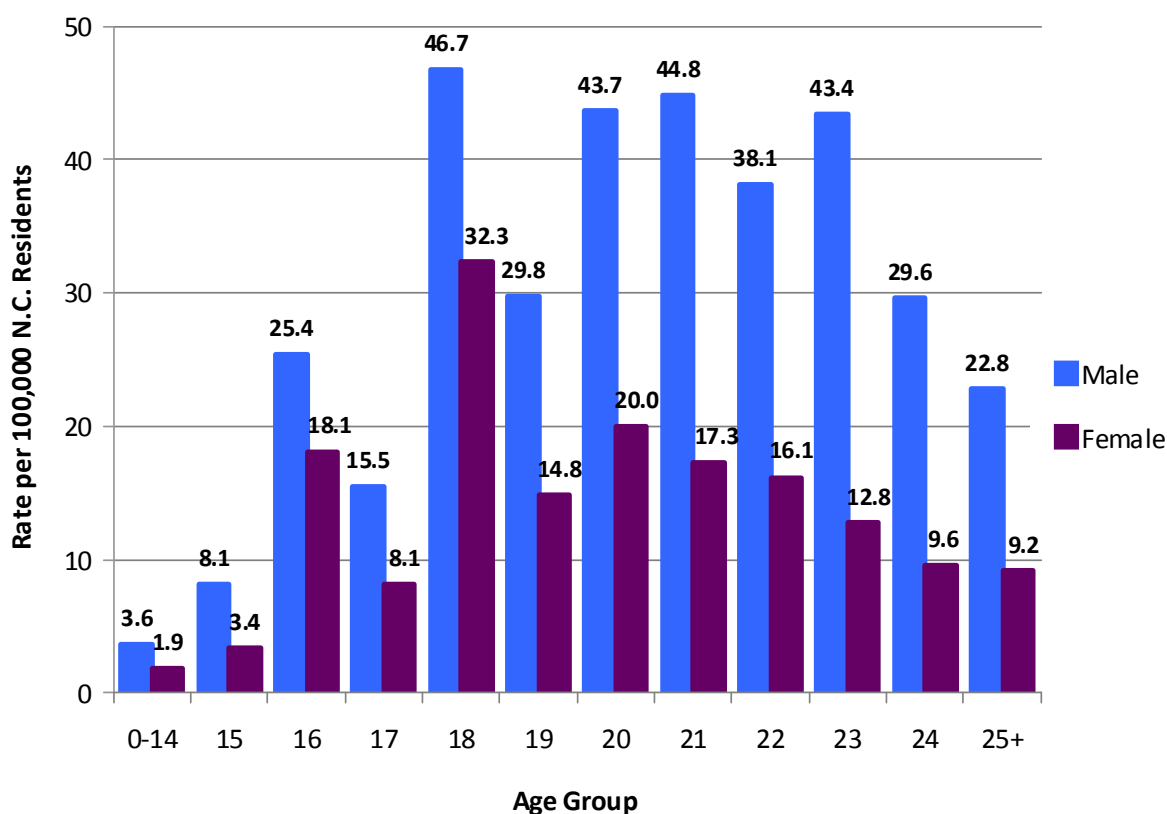
Data: N.C. Center for Health Statistics, 2009

Analysis: Injury Epidemiology & Surveillance Unit

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Rates of MVT-related deaths are highest in teenagers and young adults. In fact, an MVT-related injury is the leading cause of death for this age group. For all ages, males have higher rates of death than females. Between the ages of 15 and 16, rates increase by 214 percent for males and 433 percent for females. Rates peak for both males and females at age 18. Rates remain relatively steady between 18 and 23 years of age. After age 23, rates decrease for both sexes (Figure 4). There are a number of plausible reasons why teenagers are at a higher risk of having a fatal injury related to an MVT collision: teenagers and young adults may be more likely to engage in risky driving behavior (speeding, tailgating, etc.); they may be more likely to drive at night; and they may be less likely to wear a seat belt.¹²⁻¹⁸

Figure 4. Rates of MVT-related Deaths for Youth and Young Adults: N.C. Residents, 2009

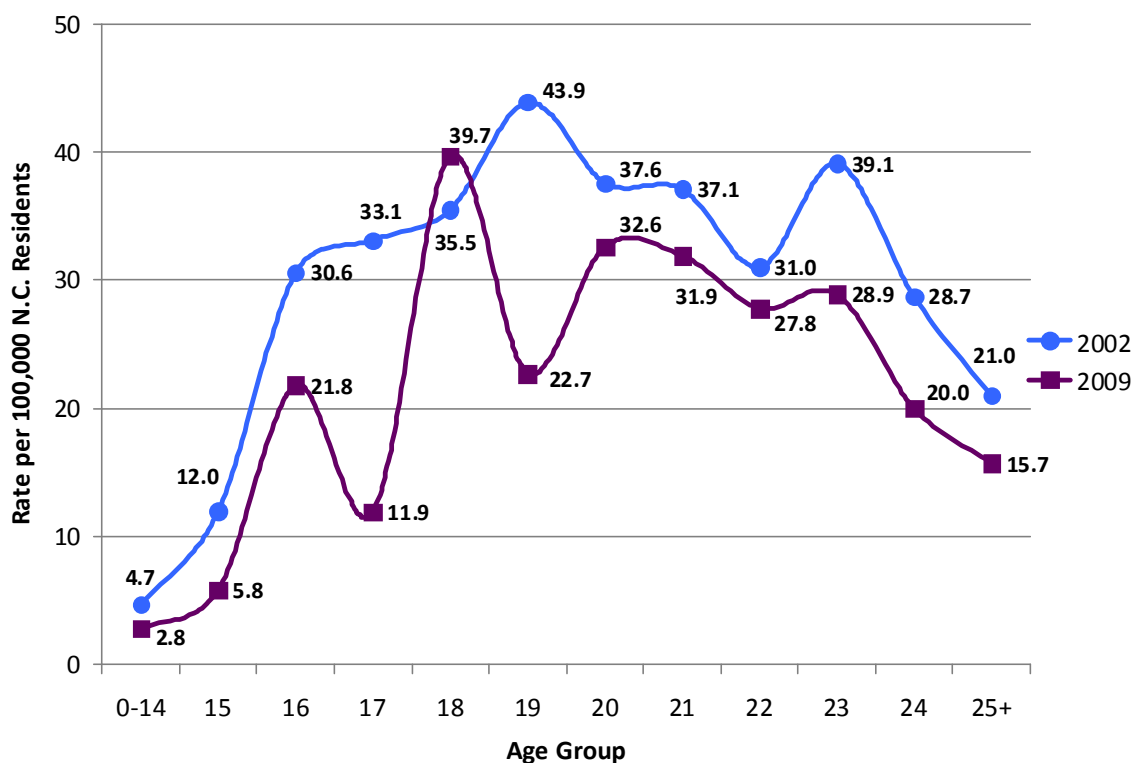


Data: N.C. Center for Health Statistics, 2009
Analysis: Injury Epidemiology & Surveillance Unit

North Carolina has a graduated license program designed to reduce the number of MVT-related deaths in new drivers. The North Carolina Graduated Driver Licensing (GDL) system went into effect on December 1, 1997. Prior to the enactment of the GDL system, all individuals between 15 and 16 years of age could drive supervised by an adult if they had passed a driver education class, vision test, sign recognition test, and a written driving test. Individuals 16 years of age and older could drive immediately following the passage of the required class and tests. After the enactment of the GDL, individuals between the ages of 15 and 18 have to hold a Limited Driving Permit (LDP) for one year. Under an LDP, drivers must be supervised by a licensed parent or legal guardian. For the first six months of the LDP, driving privileges are limited to the hours of 5 a.m. to 9 p.m. After holding the LDP for a year, individuals 16 years of age and older can progress to the Limited Provisional License (LPL). For six months, unsupervised driving is limited to the hours between 5 a.m. and 9 p.m. If the driver does not receive any traffic violations during this period, the driver advances to the Full Provisional License.¹⁹ After the passage of the GDL, rates of crashes in teenagers decreased significantly.²⁰

In 2002, N.C. passed a second law (NCGS 20-11(e)(4) that required holders of a LPL to restrict the number of passengers under the age of 21 to one (unless the passengers are immediate family). According to the University of North Carolina Center for the Study of Young Drivers, crashes in this age group have decreased by 42 percent.²¹ Figure 5 displays differences in rates between the years 2002 and 2009.

Figure 5. A Comparison between Rates of MVT Deaths Before and After Passage of a Graduated License Law: N.C. Residents, 2002 and 2009



Data: N.C. Center for Health Statistics, 2002, 2009
Analysis: Injury Epidemiology & Surveillance Unit

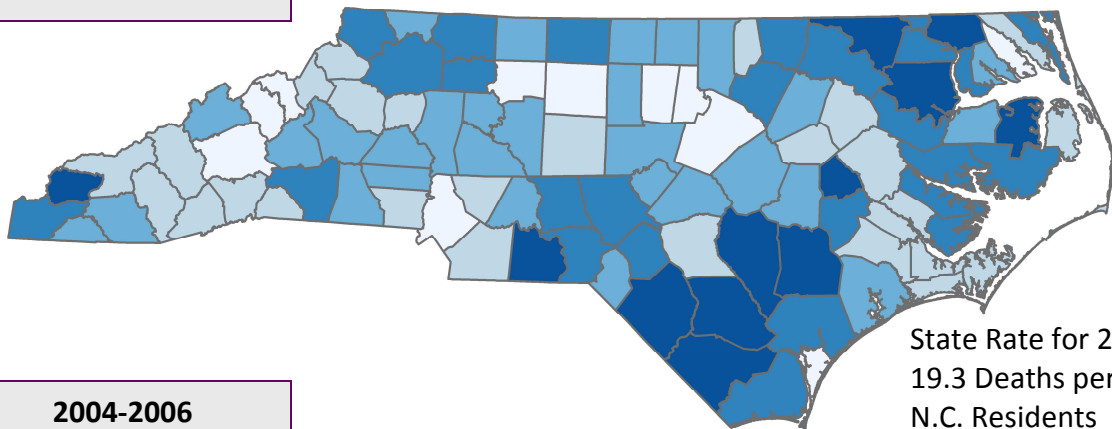
Section 3: County Rates of MVT-related Deaths

The rates of MVT-related deaths are not distributed equally across the state of N.C. Figure Six displays the rates of MVT-related deaths by county for the years 2000 through 2009. The rates should be interpreted with caution, however, as counties with fewer than 20 deaths may have statistically unreliable rates. Additionally, differences in rates between counties may be due to an array of factors including differences in population, socioeconomic factors, infrastructure, and geography. Rate cut-offs are based on natural breaks that occurred in the population between 2000 and 2003 (these cut-offs were maintained for the following years to document changes in the rate of MVT-related deaths).

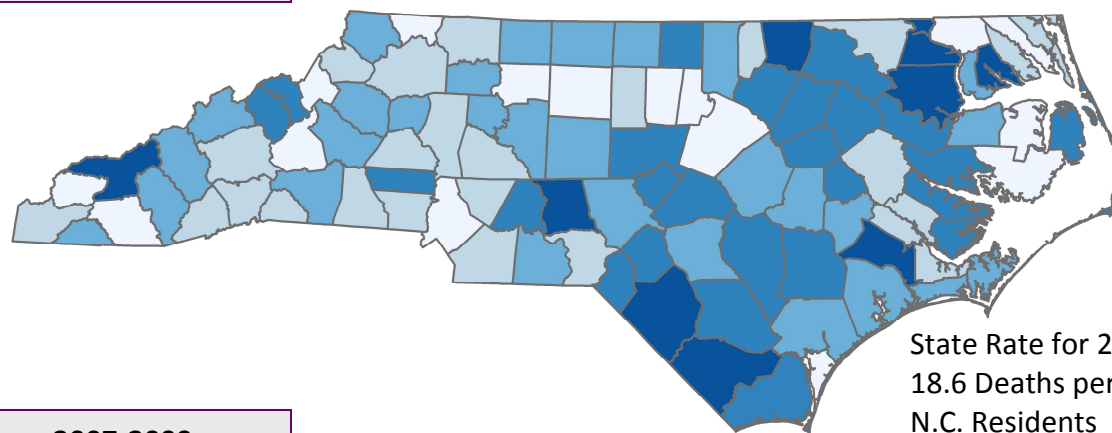
- Overall, the period from 2000-2003 had the highest average state rate of 19.3 deaths per 100,000 N.C. residents and the period from 2007-2009 had the lowest average state rate of 16.5.
- For all years, counties in the northeastern and southeastern regions of the state had the highest rates.
- For 2000-2009, of the 96 counties with 20 or more deaths, Bertie (47.2), Robeson (42.6), Columbus (40.0), Bladen (36.8), and Sampson Counties (35.7) had the highest rates of death.
- For 2000-2009, of 96 counties with 20 or more deaths, Mecklenburg (10.7), Wake (10.9), New Hanover (11.1), Avery (11.8), and Durham Counties (11.8) had the lowest rates of death.

Figure 6: Rates of MVT-related Deaths by County: N.C. Residents, 2000-2009

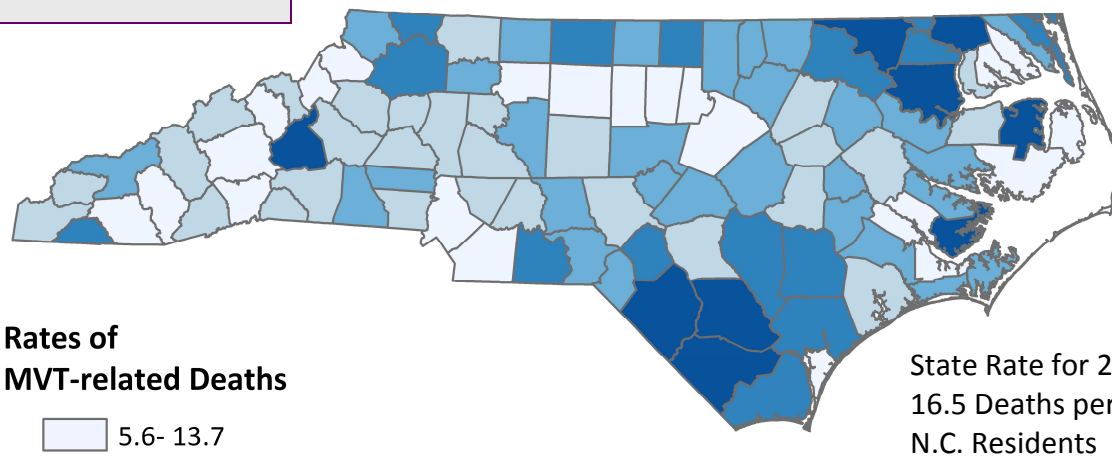
2000-2003



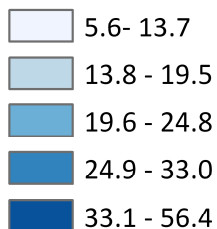
2004-2006



2007-2009



Rates of MVT-related Deaths



Data: N.C. Center for Health Statistics, 2000-2009
Analysis: Injury Epidemiology & Surveillance Unit

Section 4: Hospitalizations Due to MVT-related Injuries

Deaths are only the tip of the iceberg in regard to the total number of nonfatal injuries due to MVT crashes. In 2008, there were nearly 5 times as many hospitalizations (7,146 hospitalizations) due to MVT-related injuries than deaths (1,500 deaths). Table 2 presents hospital discharge data for the year 2008.

For 2008, the median hospital bill for all hospital discharges due to MVT crashes was about \$27,678 per admission (\$153 - \$880,052) and the total hospital charges for North Carolina were over \$360 million.

- The demographic profile of hospitalizations is similar to deaths. Males and young adults are at the highest risk of a hospitalization due to injuries sustained from a MVT crash.
- More than 60 percent of all hospitalizations are male. The rate of hospitalization is 99.7 for males and 55.2 for females.
- Hospitalization rates are lowest for children and youth between the ages of 0 and 15 (19.0) and highest for individuals between the ages of 21 and 25 (126.4).

Table 3: Selected Demographics for Hospitalizations for MVT-related Injuries: N.C. Residents, 2008

	Number	Percent	Rate*	95% Confidence Interval	
				<u>Lower</u>	<u>Upper</u>
Sex[†]					
Male	4,506	63.1%	99.7	96.7	102.6
Female	2,637	36.9%	55.2	53.1	57.4
Age Group					
0-15	379	5.3%	19.0	17.1	20.9
16-20	768	10.7%	121.2	112.6	129.8
21-25	788	11.0%	126.4	117.6	135.2
26-35	1,169	16.4%	94.4	89.0	99.8
36-45	1,201	16.8%	88.8	83.8	93.8
46-55	1,153	16.1%	88.4	83.3	93.5
56-65	731	10.2%	71.5	66.3	76.7
66-75	496	6.9%	85.7	78.2	93.2
>75	461	6.5%	97.2	88.3	106.1
Total	7,146	100.0%	77.2	75.4	79.0

*All rates are age-adjusted and per 100,000 North Carolina residents.

†Missing 3 of unknown sex.

Data: N.C. Center for Health Statistics, 2008

Analysis: Injury Epidemiology & Surveillance Unit

Section 5: Emergency Department (ED) Visits Due to MVT-Related Injuries

In 2009, there were 88,847 ED visits due to injuries caused by a MVT crash; or approximately 10 visits per hour across the state. Table 3 presents ED data for 2009.

- The demographic profile of ED visits due to MVT-related injuries differs from hospitalizations and deaths. For example, females are more likely to visit the ED than males.
- More than half of all ED visits due to MVT-related injuries are female. Females have a rate of 1,006.9 ED visits per 100,000 North Carolina residents versus a rate of 908.4 in males.
- Rates are highest for the age group of 16-20 years from age (2,052.9). Among the 16-20 year age group, 18 year-old females have the highest rates of injury (2,571.1; data are not shown).

Table 4: Selected Demographics of Emergency Department (ED) Visits for MVT-related Injuries: N.C. Residents, 2009

	Number	Percent	Rate*	95% Confidence Interval	
				<u>Lower</u>	<u>Upper</u>
Sex[†]					
Male	41,959	47.2%	908.4	899.7	917.2
Female	46,879	52.8%	1,006.9	998.1	1,015.8
Age Group					
0-15	7,515	8.5%	370.5	362.1	378.9
16-20	13,600	15.3%	2,052.9	2,018.4	2,087.4
21-25	12,697	14.3%	1,933.9	1,900.3	1,967.5
26-35	18,591	20.9%	1,511.2	1,489.5	1,532.9
36-45	14,648	16.5%	1,096.9	1,079.1	1,114.7
46-55	11,232	12.6%	852.4	836.6	868.2
56-65	6,005	6.8%	576.2	561.6	590.8
66-75	2,823	3.2%	457.4	440.5	474.3
>75	1,731	1.9%	352.6	336.0	369.2
Total	88,847	100.0%	956.6	950.4	962.8

*All rates are age-adjusted and per 100,000 North Carolina residents.

†Missing 3 of unknown sex

§Missing 8 of unknown age.

Data: N.C. DETECT, 2009

Analysis: Injury Epidemiology & Surveillance Unit

Section 6: North Carolina Department of Transportation (NC DOT)/University of North Carolina Highway Safety Research Center (UNC-HSRC) Data on Reportable Crashes in North Carolina

The University of North Carolina (UNC) Highway Safety Research Center (UNC-HSRC) collaborates with the North Carolina Department of Transportation (NC DOT) and North Carolina Governor's Highway Safety Research Program (GHSP) to provide summary statistics of crashes recorded in the NC DOT live crash database. All data are extracted from the UNC-HSRC N.C. Crash Data Query Website.²² At this time, data are incomplete for Mecklenburg County due to the implementation of a new data management system. There are slight differences in the definitions of motor vehicle-traffic related crashes between UNC-HSRC and the CDC; for consistency, the motor vehicle crashes captured by UNC-HSRC will be labeled as MVT-related crashes.

Definitions

Crashes are classified according to the N.C. DOT Division of Motor Vehicles (DMV) Crash Report Instruction Manual.²³ All reportable crashes must:

- Occur on a traffic way (defined as “any land way open to the public as a matter of right or custom for moving persons or property from one place to another”) or occur after the motor vehicle runs off a traffic way, but before events are stabilized.
- Result in at least one of the following criteria:
 - A fatality
 - A non-fatal injury
 - Total property damage of \$1,000 or more
 - A seized vehicle

After the completion of the crash investigation, the investigating agency has 10 days to submit the report to the N.C. DMV as required by N.C. General Statute 20-166.1. Information collected during the investigation includes:

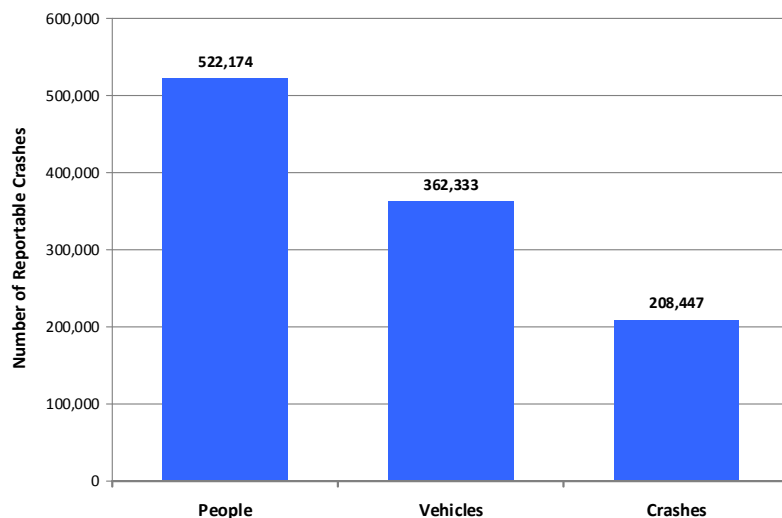
- General crash information (locality, weather, road surface condition, ambient light, etc.)
- Harmful event/contributing circumstances
- Occupant and non-motorist information (sex, age, seating position, etc.)
- Reporting and control information (number of vehicles involved, etc.)
- Driver/owner information (license number, drug/alcohol involvement, etc.)
- Sequence of events
- Vehicle information (make, year, estimated speed at time of crash, etc.)

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According to the National Safety Council (NSC), approximately 1 out of 85 individuals will perish in a motor vehicle crash; however, a person's risk of being in a nonfatal motor vehicle crash is far higher.²⁴

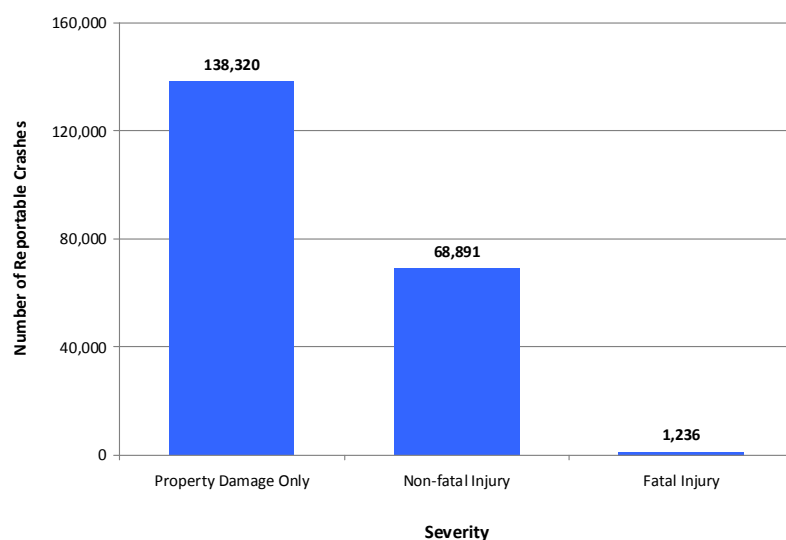
- In 2009, there were 208,447 reportable MVT-related crashes in North Carolina or approximately one crash every two and one-half minutes (Figure 7).
- On average, 1.7 vehicles and 2.5 individuals were involved in each crash (Figure 7).
- Of the 208,447 reportable crashes, most crashes (138,320) had property damage only (Figure 8).
- Nearly one-third of all reportable crashes involved non-fatal injuries (68,891; Figure 8).
- Less than 1 percent (0.6 percent) of all reportable crashes involved a fatal injury. Crashes were 112 times more likely to result in property damage and 56 times more likely to involve a non-fatal injury than a fatal injury (Figure 8).

Figure 7. Number of People and Vehicles Involved in Reportable Crashes in North Carolina: UNC-HSRC, 2009



Data: UNC Highway Safety Research Council, 2009
Analysis: Injury Epidemiology & Surveillance Unit

Figure 8. Severity of Reportable Crashes in North Carolina: UNC-HSRC, 2009



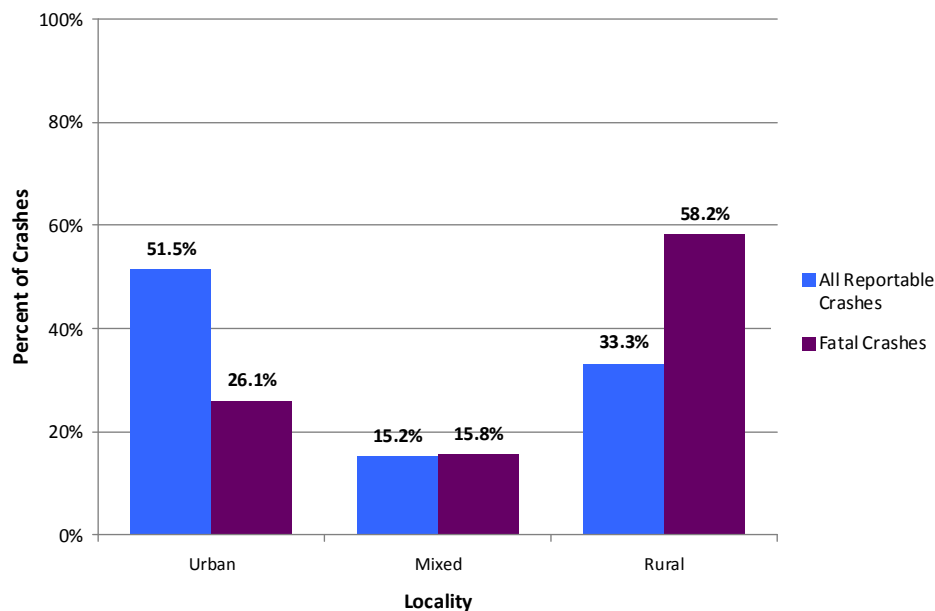
Data: UNC Highway Safety Research Council, 2009
Analysis: Injury Epidemiology & Surveillance Unit

Section 7: Locality of Reportable Crashes

National evidence suggests that the risk of being involved in a fatal motor vehicle crash is higher in rural areas than urban areas.²⁵ Although less vehicle miles are traveled in rural areas and crash density is higher in urban areas, crash severity is often higher in rural areas.^{26,27} The scientific literature proposes a number of different explanations for the difference in mortality rates for rural and urban crashes, including differences in the number of intoxicated drivers, proximity to emergency medical services, seatbelt compliance, and crash severity.^{28, 29, 30} Figure 9 presents North Carolina data for 2009.

- In 2009, 107,292 reportable crashes occurred in urban localities (more than 70 percent developed), 31,651 crashes occurred in mixed localities (30 to 70 percent developed), and 69,504 crashes occurred in rural localities (less than 30 percent developed).
- In 2009, 322 fatal crashes occurred in urban localities, 195 fatal crashes occurred in mixed localities, and 719 crashes occurred in rural localities.
- A greater percentage of fatal crashes in rural localities involved alcohol (32.8 percent versus 18.6 percent), crashes with fixed objects (32.0 percent versus 8.7 percent), overturns/roll-overs (25.5 percent versus 8.4 percent), and head-on crashes (13.6 percent versus 8.4 percent) than urban localities (data are not shown).
- A greater percentage of fatal crashes in urban localities involved pedestrians than in rural localities (16.8 percent versus 6.3 percent; data are not shown).

Figure 9. Locality* of Reportable Crashes in North Carolina: UNC-HSRC, 2009



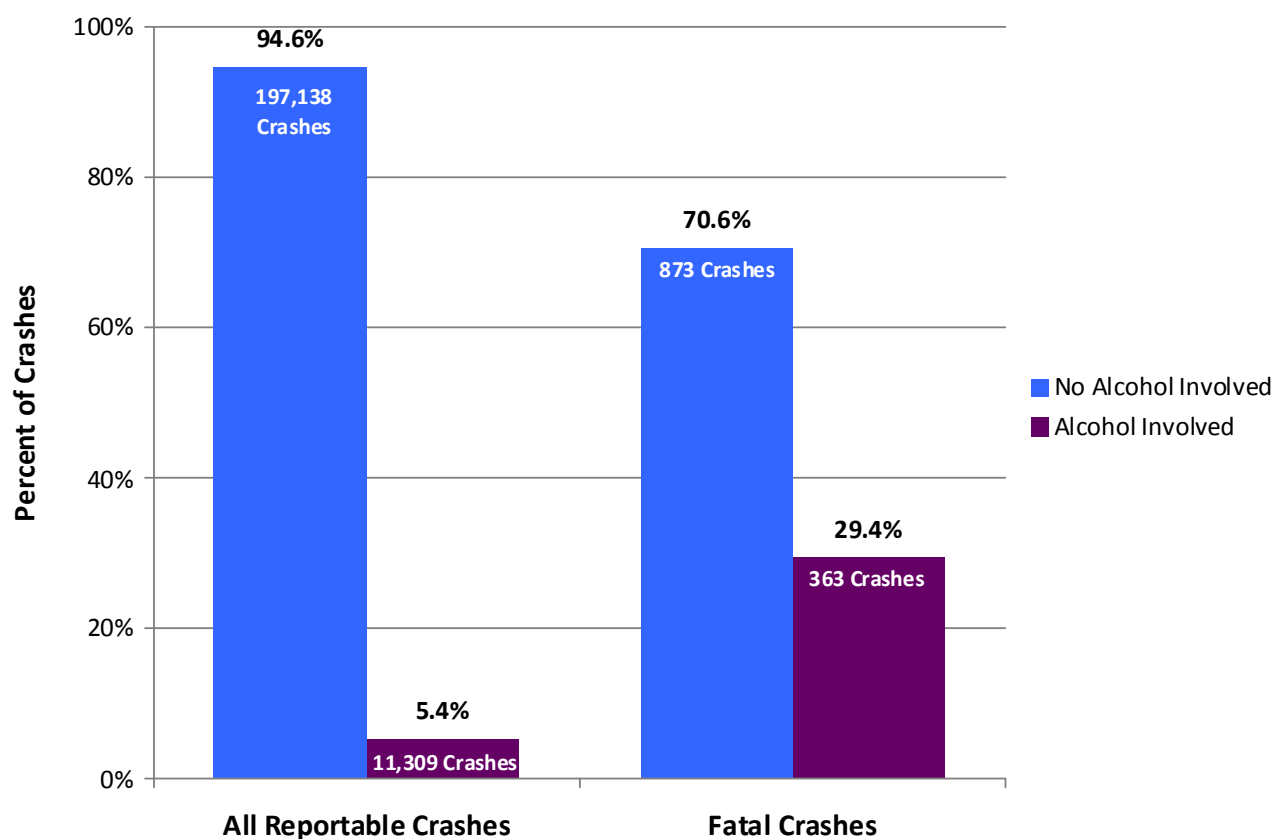
*Locality: rural is defined as <30% developed, mixed as 30% to 70% developed and urban is defined as >70% developed.

Data: UNC Highway Safety Research Council, 2009
Analysis: Injury Epidemiology & Surveillance Unit

Section 8: Alcohol Impairment in Reportable Crashes

Alcohol impairment of drivers is one of the most important contributing factors to serious car crash injuries.³¹ In North Carolina, alcohol is involved in only about 5 percent of reportable crashes; however, alcohol is involved in nearly one-third of all fatal crashes (Figure 10). In North Carolina, an individual is considered Driving While Impaired (DWI) if he/she has a blood alcohol concentration (BAC) of 0.08 percent or greater (or 0.04 percent or more if driving a commercial vehicle) or if the law enforcement officer can demonstrate that a driver's physical or mental fitness has been impaired by alcohol or drugs.³² In 2008, the North Carolina Forensic Tests for Alcohol (FTA) Branch of the Division of Public Health estimated that about 71,767 individuals were arrested for a DWI.³³

Figure 10. Alcohol Involvement in Reportable Crashes in North Carolina: UNC-HSRC, 2009



Data: UNC Highway Safety Research Council, 2009
Analysis: Injury Epidemiology & Surveillance Unit

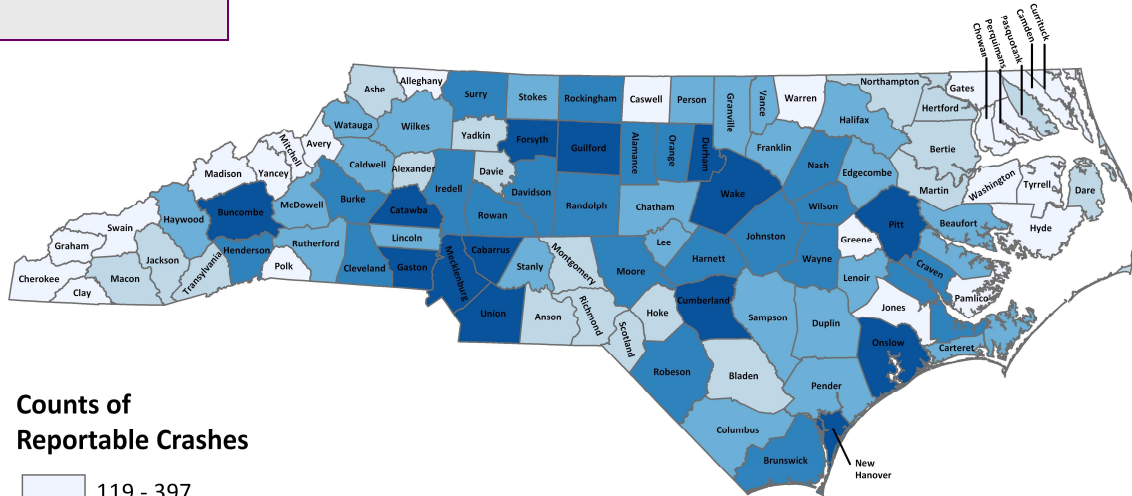
Section 9: Reportable Crashes by County

The numbers and rates of reportable MVT-related crashes by county are not distributed equally across the state. Figure 11 displays the counts and rates of reportable motor vehicle crashes by county for the year 2009. Rate cut-offs are based on natural breaks in the population distribution.

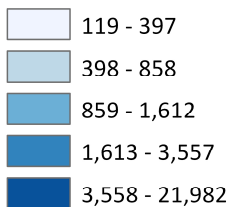
- In general, the most populous counties had the highest number of reportable crashes.
- Overall, the coastal plain had some of the highest rates of reportable crashes.
- In 2009, the average number of reportable crashes per county was 2,084 crashes.
- The average rate of reportable crashes per county was 2,222.0 crashes per 100,000 N.C. residents.
- For 2009, Wake (21,982), Mecklenburg (19,647), Guilford (11,751), Cumberland (8,271), and Forsyth Counties (8,187) had the highest number of reportable crashes. Hyde (119), Clay (136), Tyrrell (155), Camden (172), and Pamlico (201) had the lowest number of reportable crashes.
- For 2009, Tyrrell (3,800.9) Duplin (3,022.0), Columbus (2,952.7), Jones (2,869.6), and Graham Counties (2,787.2) had the highest rates of reportable crashes. Alexander (1,272.5), Clay (1,316.2), Currituck (1,338.0), Cherokee (1,440.7), and Scotland Counties (1,540.3) had the lowest rates of reportable crashes.

Figure 11. Counts and Rates of Reportable Crashes in North Carolina by County: UNC-HSRC, 2009

Count per County

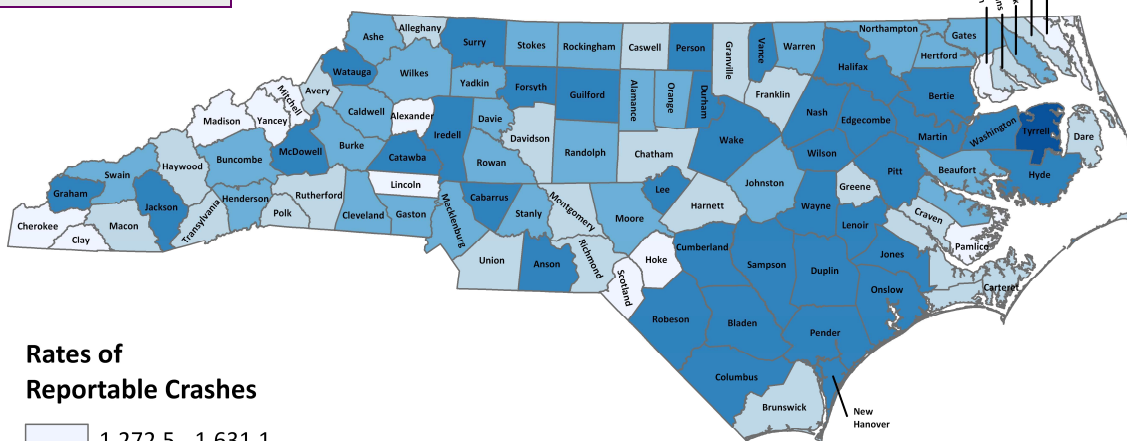


Counts of Reportable Crashes

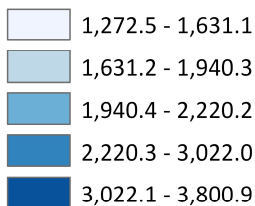


Average County Count for 2009:
2,084 Reportable Crashes per
County.

Rate per 100,000 N.C. Residents



Rates of Reportable Crashes



State Rate for 2009: 2,222.0
Reportable Crashes per 100,000
N.C. Residents

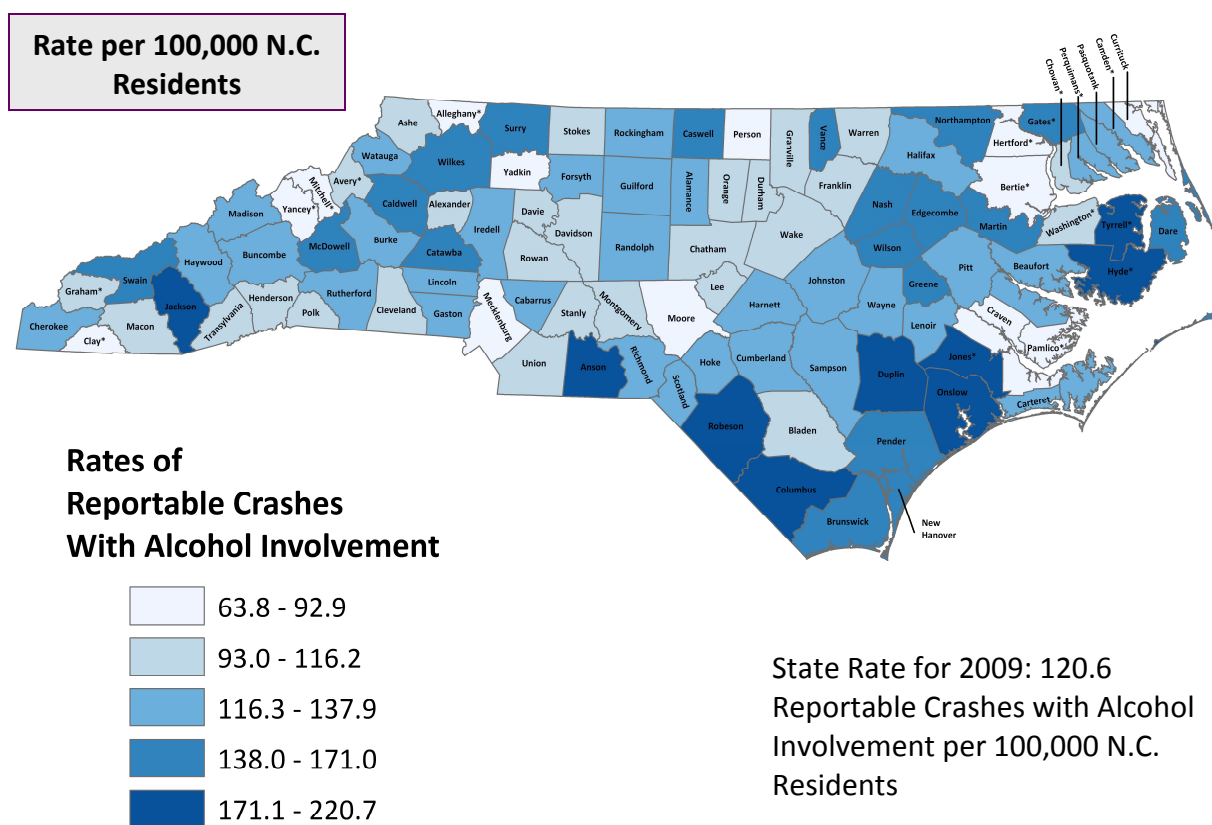
Data: UNC Highway Safety Research Council, 2009
Analysis: Injury Epidemiology & Surveillance Unit

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Figure 12 displays rates of MVT-related crashes with alcohol involvement by county for 2009. The rates should be interpreted with caution as counties with fewer than 20 deaths may have statistically unreliable rates. Rate cut-offs are based on natural breaks in the population distribution.

- For 2009, the average rate of reportable crashes with alcohol involvement was 120.6 crashes per 100,000 N.C. residents.
- Of the 83 counties with 20 or more crashes with alcohol involvement, Jackson (211.4), Robeson (201.5), Duplin (186.2), Columbus (180.7), and Onslow Counties (179.1) had the highest rates of crashes with alcohol involvement.
- Of the 83 counties with 20 or more crashes with alcohol involvement, Moore (76.9) Mecklenburg (85.8), Currituck (86.7), Craven (90.3), and Yadkin Counties (92.8) had the lowest rates of crashes with alcohol involvement.

Figure 12. Rates of Reportable Crashes with Alcohol Involvement in North Carolina by County: UNC-HSRC, 2009



Section 10: Fatality Analysis Reporting System (FARS) Data on Fatal Motor Vehicle Crashes in North Carolina

The National Highway Safety Traffic Administration (NHSTA)'s Fatality Analysis Reporting System (FARS) has collected data on all fatal crashes in all 50 states, the District of Columbia, and Puerto Rico since 1975. FARS's purpose is:

"To provide an overall measure of highway safety, to help identify traffic safety problems, to suggest solutions, and to help provide an objective basis to evaluate the effectiveness of motor vehicle safety standards and highway safety programs."³⁴

All data are extracted from the FARS Data Resource Website. FARS differs somewhat from North Carolina number of fatalities associated with motor vehicle crashes. In 2009, FARS recorded 1,208 crashes associated with 1,314 deaths compared to the 1,342 deaths associated with motor vehicle-traffic collisions identified by the state of North Carolina.³⁵

There are slight differences in the definitions of motor vehicle-traffic related fatalities between FARS and the CDC (the North Carolina Division of Public Health adheres to the CDC definition); the total number of deaths reported by FARS may differ slightly from the number reported by North Carolina. For consistency, the motor vehicle crashes captured by FARS will be labeled as MVT-related crashes.

Definitions

FARS collects data on all incidents that involve a motor vehicle crash on a traffic way (a roadway open to the public) that results in a fatality (vehicle occupant or non-motorist) within 30 days of the crash.

FARS works with state FARS analysts to gather data from some or all of the following agencies:

- Police Accident Reports
- State Vehicle Registration Files
- State Driver Licensing Files
- State Highway Department Data
- Vital Statistics
- Death Certificates
- Coroner/Medical Examiner Reports
- Hospital Medical Reports
- Emergency Medical Service Reports

Data elements are reported on four separate forms:

- **Crash:** includes location, time of crash, number of vehicles involved, weather conditions, etc.
- **Vehicle:** includes type of vehicle, role of vehicle in crash, most harmful event, etc.
- **Driver:** includes driver's record and license information
- **Person:** includes age, sex, drug/alcohol involvement, injury severity, seatbelt use, etc.³⁴

Section 11: Persons Killed in N.C. Crashes

In 2009, FARS captured 1,314 deaths due to MVT-related crashes. Table 5 displays the number of persons killed in motor vehicle crashes by the crash type.

- Three-fourths of crashes involved occupants of motor vehicles. There were nearly three times as many driver deaths as passenger deaths.
- Motorcyclists made up over 11 percent of deaths (155 deaths).
- Non-motorists made up an additional 12.5 percent of deaths. Most non-motorist fatalities were pedestrians.

Table 5: Persons Killed in N.C. Crashes by Type: FARS, 2009

	Number	Percent
Vehicle Occupants		
Drivers	734	55.9%
Passengers	256	19.5%
Unknown	5	0.4%
Subtotal	995	75.7%
Motorcyclists		
	155	11.8%
Non-motorists		
Pedestrians	146	11.1%
Pedal Cyclists	16	1.2%
Other/Unknown	2	0.2%
Subtotal	164	12.5%
Total	1,314	100.0%

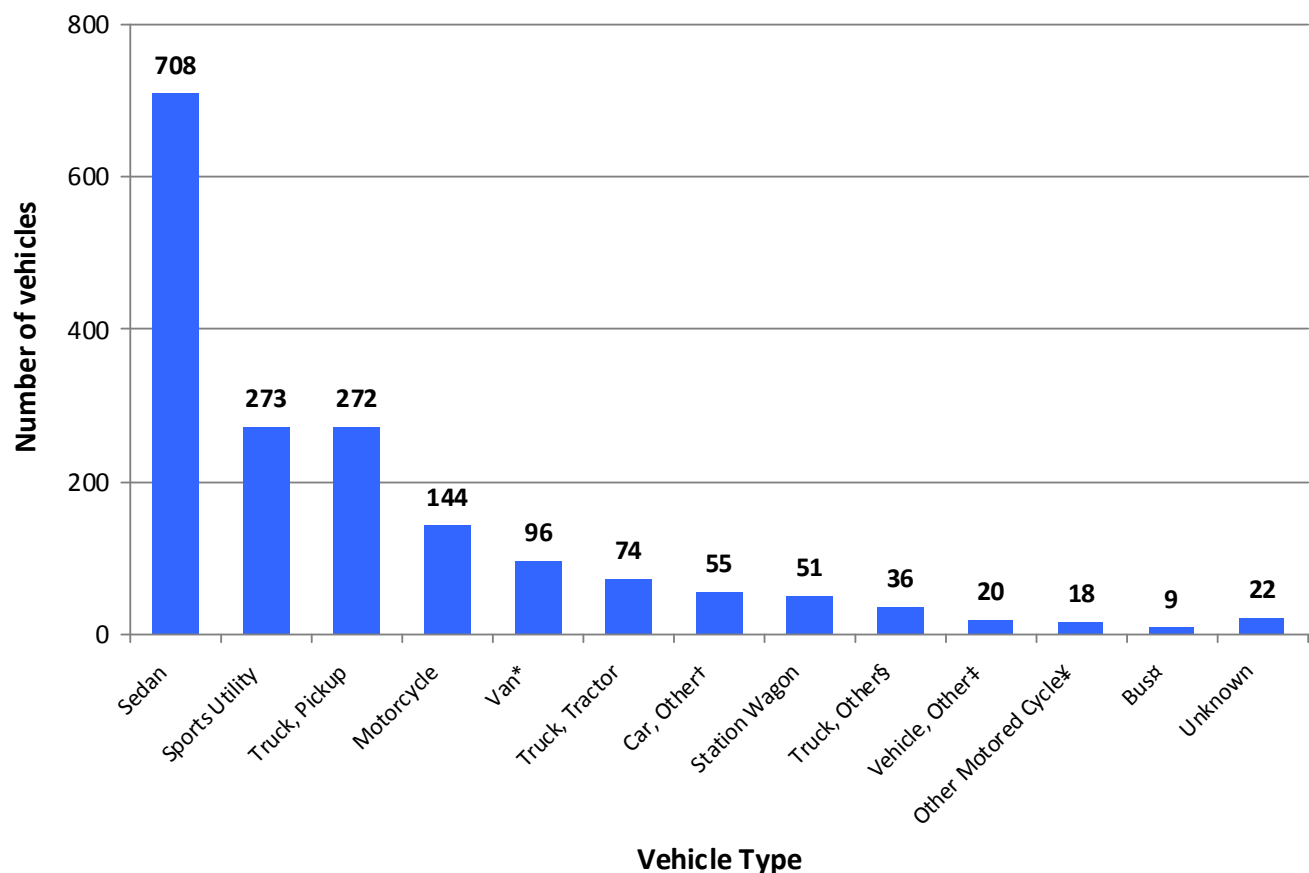
Data: Fatality Analysis Reporting System, 2009
Analysis: Injury Epidemiology & Surveillance Unit

Section 12: Vehicles Involved in Fatal Crashes

In 2009, there were 1,778 vehicles associated with the 1,208 fatal crashes identified by FARS. Figure 13 presents data on the type of vehicles involved in fatal crashes.

- In 2009, most crashes involved passenger cars (sedans, sport utility, etc.).
- Two and four-door sedans were the vehicle types most commonly involved in fatal crashes (40 percent) followed by sports utility (15 percent) and pick-up trucks (15 percent).
- Although motorcycles make up less than 2 percent of registered vehicles, motorcycles make up 8 percent of all vehicles involved in fatal crashes.³⁶ FARS estimates that per vehicle mile traveled, motorcyclists are 37 times more likely to die in a collision than an occupant of a passenger car.³⁷

Figure 13. Vehicles Involved in Fatal Crashes in North Carolina: FARS, 2009



*"Van" includes mini, large, step, and walk-in vans.

†"Car, other" includes hatchbacks, convertibles, and auto-based pickups.

‡ "Truck, other" includes single unit straight trucks

§ "Vehicle, other" includes cab-chassis based vehicles, motor-homes, and farm equipment.

¶ "Other motored cycle" includes off-road motorcycles, mopeds, minibikes, and three-wheeled cycles (not ATVs).

‡‡ "Buses" includes school, transit, and intercity buses.

Data: Fatality Analysis Reporting System, 2009

Analysis: Injury Epidemiology & Surveillance Unit

Section 13: Alcohol Involvement in Fatal Crashes

Nationally, alcohol impaired driving contributes to 32 percent of fatal motor vehicle crashes or a total of over 11,000 fatalities annually.³⁸ In 2009, 341 deaths out of a total of 1,314 motor vehicle fatalities in North Carolina were due to alcohol involvement (26 percent). Figures 14 and 15 present data on fatal crashes involving alcohol.

- In 1994, the rate of alcohol-related MVT crash fatalities was 6.4 deaths per 100,000 North Carolina residents (462 deaths; Figure 14).
- By 2009, the rate of alcohol-related motor vehicle crash fatalities had decreased by 44 percent to 3.6. This decrease is greater than the decrease in rate for all motor vehicle deaths between 1994 and 2009 (30 percent; Figure 14).
- Alcohol-related crashes occur most frequently on the weekends. Nearly one-half (48 percent) of fatal alcohol-related crashes occur during the weekend. Only one-third of crashes without alcohol involvement occur on the weekend (33 percent; data are not shown).
- Crashes without alcohol involvement peak between the hours of 3 p.m. and 6 p.m. Crashes with alcohol involvement peak between the hours of 12 a.m. and 3 a.m. (Figure 15).

Figure 14. Deaths due to Motor Vehicle Crashes with Alcohol Involvement in North Carolina: FARS, 1994-2009

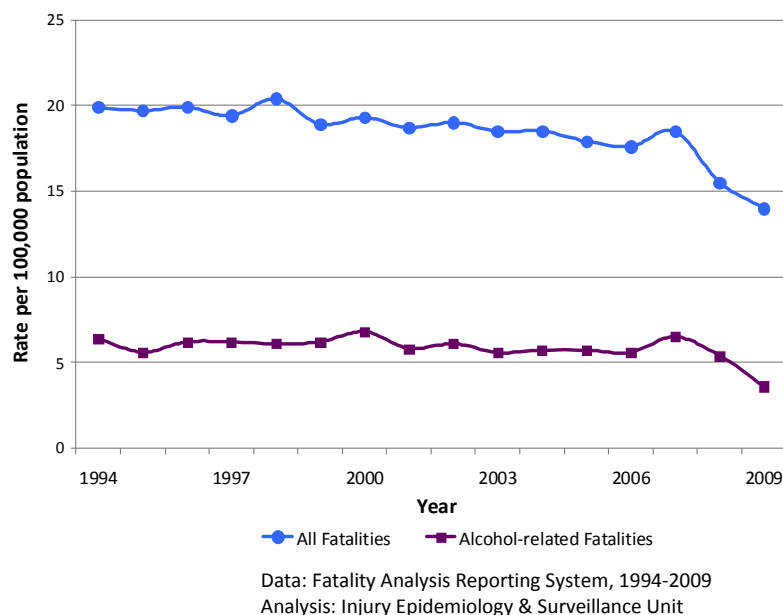
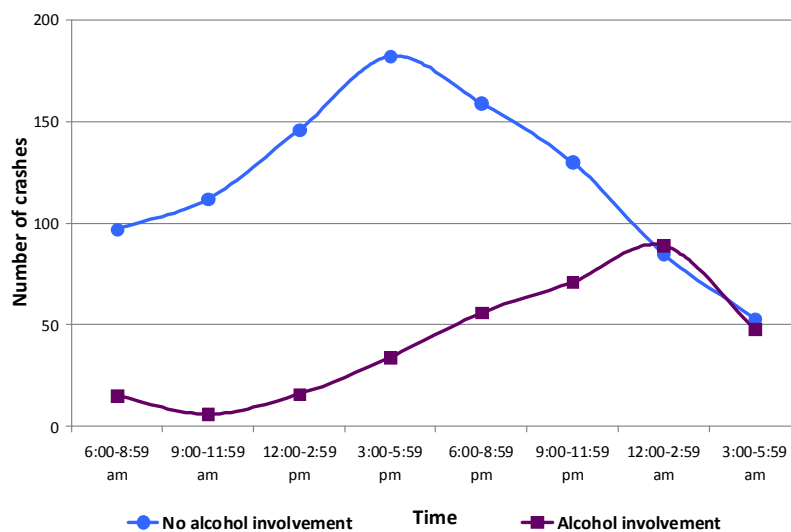


Figure 15. Time of Fatal Alcohol-related Motor Vehicle Crashes in North Carolina: FARS, 2009



Section 14: Seatbelt Use Among Fatal Crash Victims

According to the CDC, lap and shoulder seatbelts are the most effective measures to prevent death and serious injury from motor vehicle crashes.³⁹ FARS estimates back seat lap belts reduce the risk of sustaining a fatal injury by 33 percent and that front seat lap/shoulder belts reduce the risk of a fatal injury by 44 percent.⁴⁰ In North Carolina, according to the Behavioral Risk Factor Surveillance System (BRFSS), 88 percent of adults responded that they always wear a seatbelt when they operate or ride in a motor vehicle.⁴¹ According to the North Carolina Youth Risk Behavior Survey (YRBS), 93 percent of high school students report wearing a seatbelt when riding or driving a motor vehicle.⁴² Table 7 displays seatbelt usage by age for both survivors and fatalities of crashes.

- In 2009, 54.3 percent of motor vehicle crash deaths used a seatbelt and 45.7 percent did not use a seatbelt.
- Conversely, 85 percent of survivors of fatal crashes used a seatbelt.
- Of fatal crash victims, youth between the ages of 10 and 15 were the least likely to use a seatbelt (76.9 percent). Of survivors, youth between the ages of 16 and 20 were the least likely to use a seatbelt (28.8 percent).

Table 6. Seatbelt Use by Fatalities and Survivors of Crashes FARS, 2009

Seatbelt Use										
Age Group	Fatalities*					Survivors†				
	Seatbelt Used		Seatbelt Not Used		Total	Seatbelt Used		Seatbelt Not Used		Total
	Number	Percent	Number	Percent		Number	Percent	Number	Percent	
< 5	11	84.6%	2	15.4%	13	65	89.0%	8	11.0%	73
5-9	6	37.5%	10	62.5%	16	39	81.3%	9	18.8%	48
10-15	3	23.1%	10	76.9%	13	60	77.9%	17	22.1%	77
16-20	69	47.9%	75	52.1%	144	131	71.2%	53	28.8%	184
21-24	34	33.3%	68	66.7%	102	109	72.7%	41	27.3%	150
25-34	62	44.9%	76	55.1%	138	224	87.2%	33	12.8%	257
35-44	47	43.5%	61	56.5%	108	157	86.7%	24	13.3%	181
45-54	72	60.0%	48	40.0%	120	146	94.8%	8	5.2%	154
55-64	59	59.0%	41	41.0%	100	113	98.3%	2	1.7%	115
65-74	49	79.0%	13	21.0%	62	59	92.2%	5	7.8%	64
75+	82	88.2%	11	11.8%	93	33	100.0%	0	0.0%	33
Total	494	54.3%	415	45.7%	909	1,136	85.0%	200	15.0%	1,336

*Missing 53 of unknown age/seatbelt use.

†Missing 64 of unknown age/seatbelt use.

Data: Fatality Analysis Reporting System, 2009
Analysis: Injury Epidemiology & Surveillance Unit

Section 15: Conclusions

Motor vehicles are a major source of morbidity and mortality for North Carolina residents and exact a heavy toll on the life, health, and economic security of the individual, family unit, community, and state. Motor vehicle-related injuries affect all age groups, from the very young to the very old both men and women, and all races. Certain populations, such as youth and young adults, are at a greater risk of injury. Despite significant decreases in the number of deaths related to motor vehicles, motor vehicle-related injuries are still the leading cause of fatal injury and the leading cause of death in young adults in North Carolina. In order to address this complicated public health issue fully, disparate organizations with backgrounds in health, advocacy, research, education, law enforcement, and policy must form a partnership to alleviate the burden that motor vehicle-related injuries place on North Carolina. Continued population-based surveillance is necessary to provide data on changing trends regarding motor vehicle-related injuries. Hopefully, the data provided in this document and upcoming publications will be used to aid in prevention and to spur future research priorities.

Section 16: Additional Sources of Information

North Carolina:

North Carolina Division of Public Health, Injury and Violence Prevention Branch

Phone: (919) 707-5425

Email: beinjuryfreenc@dhhs.nc.gov

Website: www.injuryfreenc.ncdhhs.gov

North Carolina Division of Public Health, Forensic Tests for Alcohol Branch

Phone: (919) 707-5250

Email: cdi@dhhs.nc.gov

Website: www.ncpublichealth.com/chronicdiseaseandinjury/fta/

North Carolina Department of Transportation, Governor's Highway Safety Program

Phone: (919) 715-7000

Website: www.ncdot.org/programs/ghsp/

University of North Carolina Highway Safety Research Center

Phone: (919) 962-2202

Email: info@hsrc.unc.edu

Website: www.hsrc.unc.edu/index.cfm

National:

Centers for Disease Control and Prevention, National Center for Injury Prevention and Control

Phone: (800) 232-4636

Email: cdcinfo@cdc.gov

Website: www.cdc.gov/motorvehiclesafety/

National Highway Traffic Safety Administration

Phone: (888) 327-4236

Website: www.nhtsa.gov/

Section 17: Notes

Rates: All rates (unless documented otherwise) are per 100,000 North Carolina residents. Rates are not age-adjusted, unless labeled as such.

95 Percent Confidence Intervals: Data are frequently reported as point estimates with an associated 95 percent confidence interval. A confidence interval is the range of values within which the expected “true” value falls 95 percent of the time. In general, a rate with a large numerator will have a narrower 95 percent confidence interval than a rate with a small numerator.⁴³

Population Estimates: The State Center for Health Statistics provided population data for the years 1990–2009. These estimates originate from the National Center of Health Statistics’ Bridged Population Files.

Death Data: The State Center for Health Statistics provided death certificate data for every death in North Carolina. Only North Carolina residents with a North Carolina county address were considered in our analyses. Deaths were limited to events in which the primary cause of death was identified as an injury. Primary cause of death was assigned with the International Classification, 10th Revision (ICD-10) codes. The coding used to classify deaths due to motor vehicle-traffic (MVT) collisions was: V02–V04 (.1, .9), V09.2, V12–V14 (.3–.9), V19 (.4–.6), V20–V28 (.3–.9), V29 (.4–.9), V30–V39 (.4–.9), V40–V49 (.4–.9), V50–V59 (.4–.9), V60–V69 (.4–.9), V70–V79 (.4–.9), V80 (.3–.5), V81.1, V82.1, V83–V86 (.0–.3), V87 (.0–.8), and V89.2.

Hospital Discharge Data: The State Center for Health Statistics provided hospital discharge data for every hospital discharge of North Carolina residents. A hospital discharge occurs after a patient leaves a hospital following admission. This data does not represent number of patients, but number of discharges (multiple discharges per patient are possible). Cause of injury was assigned with International Classification, 9th Revision, Clinical Modification (ICD-9-CM) External Causes of Injury codes (E Codes). The coding used to classify hospitalizations due to motor vehicle-traffic (MVT) collisions was: E810–E819.

Emergency Department Data: The North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) is a state system that collects and monitors emergency department (ED) for public health purposes. NC DETECT receives data on at least a daily basis from hospital emergency departments statewide to provide early detection and timely public health surveillance. As of 01/2007, NC DETECT was receiving data from 90 of the 112 hospital EDs. The ED data and the hospital discharge data are not mutually exclusive. Cause of injury was assigned with International Classification, 9th Revision, Clinical Modification (ICD-9-CM) External Causes of Injury codes (E Codes). The coding used to classify ED visits due to motor vehicle-traffic (MVT) collisions was: E810–E819.

Section 18: Glossary⁹

Adult: Person 18 years of age or older at date of death/injury.

Adverse effects: An injury caused by complications following the administration of a medication or medical procedure.

Assault: Injury resulting from an act of violence where physical force by one or more persons is used with the intent of causing harm, injury, or death to another person.

Child: Person less than 18 years of age at date of death/injury.

Fall: An injury caused by descending rapidly and striking a surface.

Firearm: An injury caused by a projectile shot by a powder-charged gun. Firearm-related injuries include hand-guns, shot-guns, and rifles. Firearm-related injuries do not include paint, nail, or air guns.

Intent of injury: Whether or not an act that caused an injury was committed on purpose.

Intentional injury: An injury caused by a purposeful act by oneself (self-inflicted) or another individual (assault).

Mechanism (cause) of death: The reason or event that precipitates the death/injury.

Motor vehicle-traffic (MVT): A crash involving a motor vehicle on a public highway, street, or road.

North Carolina resident: A resident of North Carolina with a verifiable county of residence. All deaths and injuries reported in this report are North Carolina residents.

Other-not classifiable: An injury by a known cause that does not fit into an established category.

Pedal cyclist: An injury to a pedal cyclist caused by a collision with a human, animal, or inanimate object such as a vehicle.

Pedestrian: An injury to a person caused by a collision with a vehicle including a motor vehicle, bicycle, train, and etc.

Rate: Calculated as count x 100,000/population.

Self-inflicted injury: An injury caused by an act to deliberately harm oneself.

Struck: An injury caused by being hit or crushed by a human, animal, or inanimate object other than a vehicle or machinery.

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Transport-other: An injury caused by a person boarding or riding a vehicle other than a motor vehicle or bicycle such as animal-drawn vehicles, ATVs, ski-lifts, and etc.

Undetermined Intent: An injury in which the medical examiner/hospital/emergency department did not have enough information to describe the intent of injury.

Unintentional injury: An injury that is not caused by an act with intent to harm oneself or another individual.

Unspecified injury: An injury in which the medical examiner/hospital/emergency department did not have enough information to describe the cause of injury.

Section 19: References:

1. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. *North Carolina Mortality Data Files: 2000-2009* [Computer File]. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]. Accessed 6 October 2010.
2. United States Department of Health and Human Services, Centers for Disease Control and Prevention. *Definitions for WISQARS Fatal*. Atlanta, G.A.: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2007. Accessed 30 June 2010 from www.cdc.gov/ncipc/wisqars/fatal/help/definitions.htm.
3. Naumann, R.B., Dellinger, A.M., Zaloshnja, E., Lawrence, B.A., Miller, T.R. Incidence and Total Lifetime Costs of Motor Vehicle-Related Fatal and Nonfatal Injury by Road User Type, United States, 2005. *Traffic Injury Prevention*. 2010; 11 (4): 353-360.
4. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. *North Carolina Hospital Discharge Data: 2008* [Computer File]. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]; 2010. Accessed 6 October 2010.
5. The North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT). *North Carolina Emergency Department Data: 2008-2009* [Computer File]. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health; 2009. Accessed 6 October 2010.
6. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. *Web-based Injury Statistics Query and Reporting System (WISQARS)*. 2007. Accessed 6 October 2010 from www.cdc.gov/nipc/wisqars.
7. United States Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System. *Vintage Bridged-Race Postcensal Population Estimates* [Computer File]. Atlanta, G.A.: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System; 2010. Accessed 6 October 2010.
8. United States Department of Transportation. National Highway Traffic Safety Administration (NHTSA). Summary of statistical findings: highlights of 2009 motor vehicle crashes. *Traffic Safety Facts (DOT HS 811 363)*; 2010.

9. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. *Definitions from WISQARS™ Nonfatal*. 2007. Accessed 22 October 2010 from www.cdc.gov/ncipc/wisqars/nonfatal/definitions.htm.
10. World Health Organization. *International Classification of Diseases and Related Health Problems, 10th Revision*. 2007. Accessed 25 October 2010 from www.who.int/classifications/icd/en/.
11. World Health Organization. *International Classification of Diseases and Related Health Problems, 9th Revision, Clinical Modification*. 2009. Accessed 25 October 2010 from www.cdc.gov/nchs/icd/icd9cm.htm/.
12. Jonah, B.A., Dawson, N.E. Youth and risk: Age differences in risky driving, risk perception, and risk utility. *Alcohol, Drugs, and Driving*. 1987; 3 (3-4): 13-29.
13. Williams, A.F. Teenage drivers: Patterns of risk. *Journal of Safety Research*. 2003; 34: 5-15.
14. Williams, A.F. Magnitude and characteristics of the young driver crash problem in the United States. In Simpson, H. (Ed.) *New to the road: Reducing the risks of Young Motorists. Proceedings of the First Annual International Symposium of the Youth Enhancement Service*. Los Angeles, CA: University of California; 1996: 19-25.
15. Keall, M.D., Frith, W.J., Patterson, T.L. The contribution of alcohol to night time crash risk and other risks of night driving. *Accident Analysis and Prevention*. 2005; 37 (5): 816-824.
16. U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA). Increasing teen seatbelt use: a program and literature review. U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA). *Report No. DOT HS 2005 809-899*. Retrieved 26 October 2010 from www.nhtsa.gov/people/injury/NewDriver/TeenBeltUse/images/DOTHS809899TeenBeltUse.pdf
17. Simons-Morton, B., Lerner, N., Singer, J. The observed effects of teenage passengers on the risky driving behavior of teenage drivers. *Accident Analysis and Prevention*. 2005; 37 (6): 973-982.
18. Farrow, J.A. Young driver risk taking: A description of dangerous driving situations among 16- to 19-year old drivers. *International Journal of Addictions*. 1987; 22 (12): 1255-1267.
19. North Carolina Department of Transportation, Division of Motor Vehicles. *Driver Services: License Eligibility/Requirements*. North Carolina Department of Transportation, Division of Motor Vehicles, 2010. Accessed 25 October 2010 from www.ncdot.org/dmv/driver_services/graduatedlicensing/requirements.html.

20. Foss, R.D., Feaganes, J.R., Rodgman, E.A. Initial Effects of Graduated Driver Licensing on 16-Year-Old Driver Crashes in North Carolina. *The Journal of the American Medical Association*. 2001; 286 (13): 1588-1592.
21. University of North Carolina-Chapel Hill, Highway Safety Research Center, Center for the Study of Young Drivers. Graduated Driver Licensing. University of North Carolina-Chapel Hill, Highway Safety Research Center, Center for the Study of Young Drivers. Accessed 25 October 2010 from www.csyd.unc.edu/issues/graduated_driver_licensing.html.
22. University of North Carolina-Chapel Hill, Highway Safety Research Center, N.C. Crash Data. *N.C. Crash Data Query Web Site*. UNC-Chapel Hill, Highway Safety Research Center, N.C. Crash Data. Accessed 27 October 2010 from www.hsrc.unc.edu/crash/index.cfm.
23. North Carolina Department of Transportation, Division of Motor Vehicles. *North Carolina Crash Report Instruction Manual*. North Carolina Department of Transportation, Division of Motor Vehicles. 2006. Accessed 27 October 2010 from www.ncdot.org/doh/preconstruct/traffic/safety/reports/TSI/DMV349_Manual.pdf.
24. National Safety Council. Lifetime odds of death from selected causes, United States, 2006 (figure). *Injury Facts* (2010 ed.). 2010. Accessed 01 November 2010 from www.nsc.org/news_resources/Documents/nscInjuryFacts2011_037.pdf.
25. Brown, L.H., Khanna, A., Hunt, R.C. Rural versus urban motor vehicle crash death rates: 20 years of FARS data. *Prehospital Emergency Care*. 2000; 4 (1): 7-13.
26. United States Department of Transportation, National Highway Traffic Safety Administration. Rural and urban crashes—A comparative analysis. *Research Notes*. 1996. Accessed 01 November 2010 from ntl.bts.gov/lib/000/800/805/00326.pdf.
27. Zwerling, C., Peek-Asa, C., Whitten, P.S., Choi, S.W., Sprince, N.L., Jones, M.P. Fatal motor vehicle crashes in rural and urban areas: Decomposing rates into contributing factors. *Injury Prevention*. 2005; 11:24-28.
28. Muelleman, R.L., Mueller, K. Fatal motor vehicle crashes: Variations of crash characteristics within rural regions of different population densities. *Journal of Trauma*. 1996; 41 (2): 315-320.
29. Muellman, R.L., Wadman, M.C., Tran, T.P., Ullrich, F., Anderson, J.R. Rural motor vehicle crash risk of death is higher after controlling for injury severity. *Journal of Trauma*. 2007; 62 (1): 221-225.
30. Rakauskas, M.E., Ward, N.J., Gerberich, S.G. Identification of differences between rural and urban safety cultures. *Accident Analysis and Prevention*. 2009; 41 (5): 931-937.
31. Connor, J. Norton, R., Ameratunga, S., Jackson, R. The contribution of alcohol to serious car crash injuries. *Epidemiology*. 2004; 15 (3): 337-344.

32. North Carolina Department of Transportation, Division of Motor Vehicles. *North Carolina Driver's Handbook*. North Carolina Department of Transportation, Division of Motor Vehicles. 2009. Accessed 03 November 2010 from www.ncdot.org/dmv/driver_services/drivershandbook/.
33. Glover, P. North Carolina Department of Health and Human Services, Division of Public Health, Forensic Tests for Alcohol Branch. *Personal Correspondence*. North Carolina Department of Health and Human Services, Division of Public Health, Forensic Tests for Alcohol Branch. 2008.
34. United States Department of Transportation, National Highway Safety Traffic Administration, Fatal Analysis Reporting System. *Fatal Crash Data Overview, DOT HS 809 726* [Brochure]. United States Department of Transportation, National Highway Safety Traffic Administration, Fatal Analysis Reporting System. 2005. Accessed 03 November 2010 from www-nrd.nhtsa.dot.gov/Pubs/FARSBrochure.pdf.
35. United States Department of Transportation, National Highway Safety Traffic Administration, Fatal Analysis Reporting System. *Fatal Analysis Reporting System Data Resource Website*. United States Department of Transportation, National Highway Safety Traffic Administration, Fatal Analysis Reporting System. 2005. Accessed 03 November 2010 from www-fars.nhtsa.dot.gov/Main/index.aspx.
36. United States Department of Transportation, Federal Highway Administration. *Table MV-1. Highway Statistics 2008 State Motor Vehicle Registrations*. United States Department of Transportation, Federal Highway Administration. 2009. Accessed 04 November 2010 from www.fhwa.dot.gov/policyinformation/statistics/2008/mv1.cfm.
37. United States Department of Transportation, National Highway Safety Traffic Administration, Fatal Analysis Reporting System. Motorcycles. *Traffic Safety Facts DOT HS 811 159*. 2009. Accessed 04 November 2010 from www-nrd.nhtsa.dot.gov/Pubs/811159.pdf.
38. United States Department of Transportation, National Highway Safety Traffic Administration, Fatal Analysis Reporting System. Alcohol-impaired driving. *Traffic Safety Facts DOT HS 811 155*. 2009. Accessed 04 November 2010 from www-nrd.nhtsa.dot.gov/Pubs/811155.PDF.pdf.
39. Task Force on Community Preventive Services. Recommendations to reduce injuries to motor vehicle occupants. Increasing child safety seat use, increasing seatbelt use, and reducing alcohol-impaired driving. *American Journal of Preventive Medicine*. 2001; 21 (4S): 16-22.
40. Morgan, C. Effectiveness of lap/shoulder belts in the back outboard seating positions. Washington DC: U.S. Department of Transportation, National Highway Safety Administration. DOT HS 808 945. 1999. Accessed 13 December 2010 from www-nrd.nhtsa.dot.gov/Pubs/808945.PDF.

41. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics. *North Carolina Behavioral Risk Factor Surveillance System*. Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]; 2008. Accessed 13 December 2010 from www.schs.state.nc.us/SCHS/data/brfss.cfm.
42. North Carolina Department of Public Instruction, North Carolina Healthy Schools. *North Carolina Youth Risk Behavior Survey*. Raleigh, N.C.: North Carolina Department of Public Instruction, North Carolina Healthy Schools. [Producer and Distributor]; 2009. Accessed 13 December 2010 from www.schs.state.nc.us/SCHS/data/brfss.cfm.
43. Buescher, P.A. Problems with rates based on small numbers. *Statistical Primer*. North Carolina Department of Health and Human Services, Division of Public Health, State Center for Health Statistics [Producer and Distributor]; Raleigh, N.C.: North Carolina Department of Health and Human Services, Division of Public Health; 2008. Retrieved 04 November 2010 from www.schs.state.nc.us/SCHS/pdf/primer12_2.pdf.